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FEEDING OF THE RINGED SEAL (Pusa hispida Schr.)

By G.A. Fedoseev

In the literature, the feeding of the ringed seal is discussed /216* only for the Canadian sector of the Arctic (McLaren, 1958), the Barents and Kara seas (K.K. Chapskii, 1940; G.F. Kurcheva, 1948; M.P. Vinogradov, 1949). For the rest - the Sea of Okhotsk, the Bering Sea, the East Siberian and Laptev seas, information on feeding, as well as other biological data, is either nonexistent or extremely inadequate.

This work discusses the feeding of the ringed seal of the Sea of (Pusa hispida ochotensis Pall.) and makes an attempt to compare it with the feeding of the other subspecies.

Comparison of the feeding of the ringed seal in different regions provides some explanation of the unique seasonal distribution of its subspecies and a more complete picture of the ecology of this seal as a species on the whole.

The work is based on original data collected in 1960-1963 in the Sea of Okhotsk and some published data.

In studying feeding, the contents of 159 stomachs of Okhotsk ringed seal (of 550 examined) were analysed. The bulk of the data was obtained from the regions of Tauisk Bay, and Babushkin Kekurnyi, Shel'ting and

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and Ushka Gulfs. There was no marked difference in the species makeup of the contents of seal stomachs for different regions and years. For this reason, all the original material on seal feeding has been combined.

The stomach contents of ringed seal were weighed in a pan balance (5 kg). In some cases, individual components were weighed on dispensing balances. Components of feeding were determined both in the field and the office. Only the easily recognizable components were identified in the field. Identification was based on 1960 samples and was done by Ya. I. Zhitlo, a member of the Magadan branch of TINRO.

The literature on the feeding of the Okhotsk ringed seal in most cases gives only a list of the feeding components found without giving a quantitative analysis. P.G. Nikulin (1937) noted that the feeding of the ringed seal consists of small fish (navaga, smelt) and crustaceans. S.P. Naumov (1941), in discussing the feeding of the Okhotsk ringed seal, noted that in June 1929, he found mainly shrimp (Sclerocrangon) in seal stomachs. Gammarids (gammarus) and navaga remains were found in some stomachs. In July off the western shores of Sakhalin Island, the Okhotsk ringed seal, according to S.P. Naumov, pursues smelt and partly feeds on crustaceans, while in the second half of the summer and in the fall (until October), it consumes gobies, whitefish, navaga and crustaceans. S.Yu. Freiman (1936) also mentioned the feeding of ringed seal on fish, /217 noting that the approaches of this seal to the shores of Gizhiginsk Bay are connected with the presence of navaga. In June 1939, G.A. Pikharev (1946) found food in only 16 of 377 ringed seal stomachs examined. Pikharev explained the low number of stomachs with contents by the fact that digestion is rapid in seals. In describing food components, he noted crustaceans were found in 10 stomachs, among them: Thysanoessa raschii,

Themisto compresso f. bispinosa, Mesidothea, Gammarus schmidtii and Anonym nugax.

Only fish was found in 5 stomachs: Korean cod (Theragra chalcogramma), smelt (Hypomesus olidus Pall.) and herring (Clupea haregnus Pall.). Food was mixed in one stomach.

Observations on the feeding of ringed seal (Table 2, Fig. 1) indicate a rather large diversity of feeding components and marked seasonal changes. Higher crustaceans make up the bulk of ringed seal feeding. Euphausids of the genus Thysanoessa are found the most frequently, having been found in 137 of 159 food-containing stomachs (87%). Amphipoda and Decapoda are also found relatively frequently in relation to other food components, in 70 (44%) and 52(32%) of stomachs. Other crustaceans are found considerably more rarely: Mysidacea have been found in 21 stomachs (14%), Isopoda in 7(4%) and Copepoda in 3 (1%). Fishes were found in 44 stomachs (28%).

In the spring, the ringed seal feeds actively on Euphausiacea. In 128 individuals examined in March-April 1961 and 1963, food was found in 98 (77%) and consisted almost exclusively of euphausids. The amount of these entomostracans in ringed seal stomachs often reached 700g or more (Table 2, Fig. 1).

During the moult (May-June), the feeding activity of the Okhotsk ringed seal is markedly diminished, but does not stop, as might appear at first glance from stomach analysis. The fact is that during the moult, the animals spend much time on ice floes, and since their food is rapidly digested, the stomach is empty in most animals taken. For example, in 397 animals which we examined in May-June, only 47 had food remains in the stomach and 39 in the intestine. In all, food remains were found in

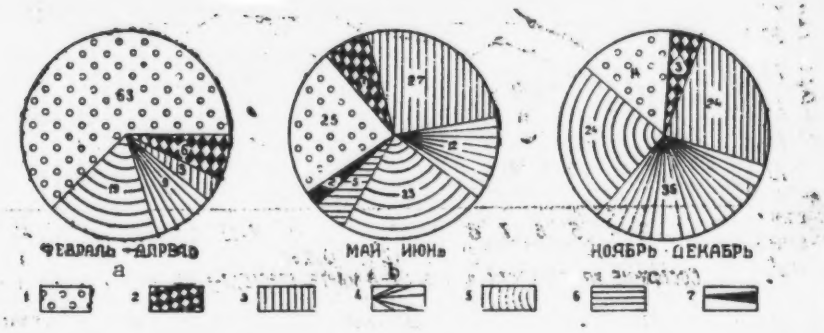

Fig. 1. Weight ratio (in %) of food components of the Okhotsk ringed seal by seasons of the year:

1 - euphausids, 2 - Mysidacea; 3 - Decapoda; 4 - fishes; 5 - Amphipoda; 6 - Copepoda; 7 - Isopoda.

a - February-April; b - May-June; c - November-December.

only 21% of animals examined. It is noteworthy that the number of food 218
components increases considerably during the moult (Fig. 1). This is due to the fact that in May and especially June, when mass moult occurs in the ringed seal, the animals spend a large part of the day on drift ice and must feed on any food which they encounter. The animals become very thin during the moult (May-June) (Fig. 2). With the end of moult (end of June - first ten days of July), the seal begins to feed actively. During the period of intensive feeding, the seal is distributed over the greatest part of its range. The seals are constantly afloat. With the end of the seal take in the summer and early fall, it becomes difficult to study its feeding, about which we have only indirect observations on distribution and behaviour.

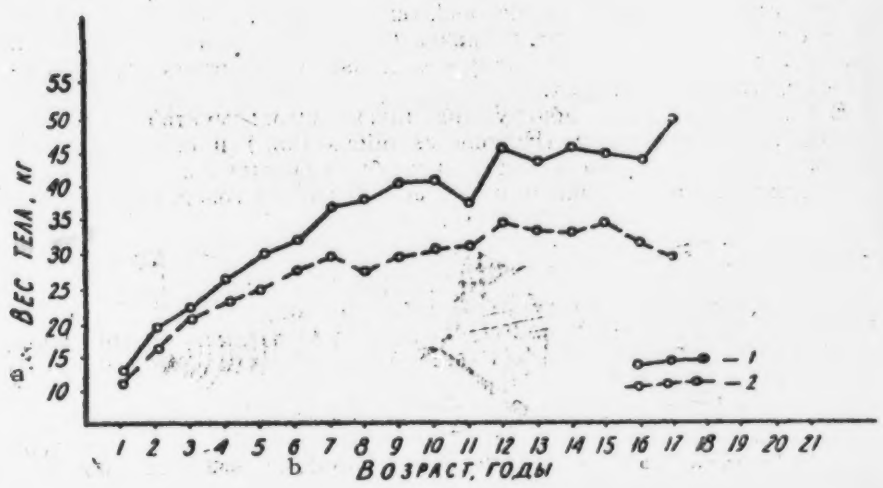

Fig. 2. Condition of Pusa hispida Schr.
a - body weight, kg; b - age, years.
1 - March-April; 2 - May-June /average data/.

Based on the reports of a number of investigators and our own observations, in July-September the ringed seal for the most part goes away from shores and accumulating mainly in regions of zooplankton development on the continental shelf, is annually found singly and in small groups (20-60 head) in almost the entire northern part of the Sea of Okhotsk. There are also reports in the literature about accumulations of ringed seal in the summer months. For example, S.Yu. Freiman (1935) reports that he found enormous accumulations of this seal afloat from Otlichitel'nyi Cape to Aldoma in August 1929 and that in his opinion the seal was pursuing a school of some sort of small fish, apparently capelin. P.G. Pikulin (1937) observed a large accumulation of Okhotsk ringed seal afloat in the region of Reineke and Men'shikov islands.

Thus the constant dwelling of the Okhotsk ringed seal in the summer in regions of mass development of zooplankton suggests that in this period,

just as in the spring, the ringed seal feeds on planktonic forms of crustaceans and fish, concentrating to forage in these regions. We are inclined to consider that in the summer in the northern part of the Sea of Okhotsk, the ringed seal feeds mainly on euphausids, since, according to L.A. Ponomareva (1963), the accumulation of these entomostracans in surface layers reaches its maximum at this time. This hypothesis is confirmed by the following fact: at the end of the winter and in the spring, the accumulation of euphausids is considerably smaller than in the summer, while the food of the ringed seal still consists almost /219 exclusively of these entomostracans, despite the accumulations of spawning navaga and herring at the same time. This fact indicates that euphausids are evidently the prefered food of the ringed seal.

TABLE 1

Distribution of examined ringed seal stomachs in time and degree of fulness

Time of year	Number of stomachs			Weight of stomach contents, in g	
	Total	including with food Number	%	Limits of variation	average
February-April	128	98	77	60-950	370
May-June	397	47	12	40-560	210
November-December	25	14	56	150-600	350
Total	550	159	29	40-950	320

The period of intensive feeding is not limited to the summer forage, but includes the fall and part of the winter. In October and the beginning of November, the ringed seal concentrates en masse in bays, gulfs and coves. In our opinion, the fall approaches of the ringed seal to the coastal zone are a regular process of seasonal change in range, caused by the movement of seals into regions with different feeding conditions.

Judging by stomach dissections, in the fall-winter months, the main food components of the ringed seal are navaga, smelt, herring, sometimes gobies, sand lance and other fishes. Mainly nectobenthic forms of crustaceans are found: shrimps (Hipolitidae), (Pandalidae) and even mollusks (Gastropoda). The planktonic forms of crustaceans are found more rarely in stomachs at this time than at other periods. This is apparently due to a decrease in the abundance of these entomostracans due to their consumption by fishes, whales, birds and seals, and also to the migration of plankton from the surface layers to the deep as the result of the fall cooling of the surface waters.

The marked decrease in the condition of ringed seal in May-June (Fig. 2) is due to the moult. According to our measurements, the thickness of the fat layer hardly changes from November until the end of April and is 5-8 cm.

The food composition hardly changes with age. Fry and yearlings are an exception. Their food consists for the most part of small crustaceans - euphausids and amphipods. Even in the fall, fishes and large crustaceans are found in the food of young ringed seals less often than in adult animals.

TABLE 2

List of food componenets of ringed seal.

Food component	Canadian sector of Arctic	European sector of Arctic	Sea of Okhotsk
Copepoda	+	-	+
Calanus hyperboreus Kroyer	+	-	-
Pareuchaeta norvegica Boeck	+	-	-
Cirripedia	+	-	-
Balanidae	+	-	-

TABLE 2 (Cont'd)

/220

Разноногие раки — Amphipoda	+	÷	+
Gammarus setosus Demet	+	—	—
Gammarus oceanicus Segerst	+	—	—
Gammarus wilkitzkii Birula	+	—	—
Gammarelbus homari Fabr	+	—	—
Gammaracanthus loricatus Sabine	+	÷	—
Anonyx nugax Phipps	+	÷	+
Socarnes bidenticulatus Bate	+	—	—
Stegocephalus inflatus Krõyer	+	—	—
Ampelisca eschrichti Krõyer	+	—	+
Acanthostepheia sp.	—	÷	—
Atylus carinatus Fabr.	+	—	—
Rhachotropis aculeata Lepechin	+	—	—
Pontogeneia inermis Krõyer	+	—	—
Amphithopsis longicaudata Boeck	+	—	—
Ischyrocerus anguipes Krõyer	+	—	—
Hyperia galba Mantagu	+	—	—
Themisto libellula Mant.	+	+	+
Pleudalibrotus biulai (gurjanova)	—	÷	—
Pseudlibrotus sp.	—	÷	—
Десятиногие раки — Decapoda	+	+	+
Pasiphaea pacifica Rathbun	—	—	+
Pandalus sp.	—	—	+
Pandalus goniurus Stimpson	+	—	—
Pandalus montagui Leach.	—	—	+
Spirontocaris sp.	—	÷	+
Spirontocaris murdochi Ratbun	—	—	+
Spirontocaris spinus Sawerby	+	—	—
Spirontocaris phippsi Krõyer	+	—	—
Eualus fabricii Krõyer	+	—	—
Eualus gaimardi Milne-Edwards	+	—	—
Lebbeus groenlandica Fabr.	+	—	—
Lebbeus polaris Sabine	+	—	—
Расщепленноногие раки — Mysidacea	+	+	+
Mysis oculata Fabr	+	÷	—
Mysis mifta Lilljeborg	+	—	—
Черноглазки — Euphausiacea	+	+	+
Thysanõessa inermis Krõyer	+	—	—
Thysanõessa raschii Sars.	—	÷	+
Равноногие раки — Isopoda	—	+	+
Mesidothea entomon	—	+	+
Idothea ochotensis Brandt	—	—	+
Брюхоногие моллюски — Gastropoda	+	—	+
Margarites helicina Phipps	+	—	+
Turritellidae	+	—	+
Двустворчатые моллюски — Bivalvia	+	—	+
Limacina helicina Phipps	+	—	+
Nucula tenuis Montagu	+	—	—
Головоногие моллюски — Cephalopoda	+	÷	—
Многощетинковые черви — Polychaeta	+	+	—
Maldanidae	+	—	+

TABLE 2 (Conclusion)

FISHES

Сайка Boreogadus saida	+	+	—
Гренландский палтус Reinhardtius hippoglossoides Walbaum	+	—	—
Песчанка Ammodytes sp.	+	—	+
Морской петух Triglops sp.	+	—	—
Островосый триглопс Triglops pingeli Reinhardt	+	—	—
Люмпенус Lumpenus sp.	+	—	—
Люмпенус фабрициуса Lumpenus fabricii Reinhardt.	+	—	—
Ликоды Lycodes sp.	+	—	—
Бычки Cottidae	+	+	+
Навага Eleginus navaga	—	+	+
Полярная камбала Liopsetta glacialis	—	+	—
Корюшка Osmerus sp.	—	+	+
Морские слизни Liparis liparis	+	—	—
Минтай Theragra chalcogramma	—	—	+
Сельдь Clupea harengus	+	+	+
Мойва Mallotus sp.	—	+	+
Треска Gadus morhua Linne	—	+	—
Пикша Melanogrammus sp.	—	+	—
Омуль Coregonus autumnalis Pall.	—	+	—
Семга Salmo salar Linne	—	+	—
Голец Salvelinus sp.	—	+	—

Note. "+" food component is found; "-" food component has not been registered.

Comparison of the feeding of the ringed seal of Okhotsk with that of the other subspecies of this seal (Table 2) shows a striking similarity in food components with some differences in species apparently /221 due to the specific conditions of the biocoenoses of different seas. As a general pattern, the ringed seal feeds mainly on crustaceans for most of the year in many regions of the Arctic and the Far East. Fish predominates in its diet only in late fall and winter. But the importance of crustaceans and fishes in feeding of ringed seal is different in different regions.

Arctic cod is the main fish component of the feeding of ringed seal in most Arctic seas. It is one of the fishes which are most accssible to ringed seal. Another distinctive feature of the feeding of the ringed seal in Arctic seas is the fact that Mysis oculata makes up a large portion of the crustaceans in its diet. These entomostracans can form accumulations in the freshened waters of bays, gulfs and the pro-estuarine reaches of rivers. The mass accumulation of Mysis oculata in these regions is due to the presence of a peculiar "polar front" at the juncture of river and sea waters in the pro-estuarine reaches of large rivers.

In the northern part of the Sea of Okhotsk, there is no extensive freshening of sea water because of the absence of large rivers and Mysis oculata does not form mass accumulations. Euphausids make up the bulk of the crustaceans in ringed seal feeding. In the northern part of the Sea of Okhotsk, the ringed seal finds accumulations of euphausids in the surface layer of polynyas and leads. Euphasids are concentrated in March-April for mating, which is followed in four-six weeks by spawning, for which these entomostracans rise to the surface layers (L.A. Ponomareva, 1963).

The peculiarities of the distribution of food objects also determines the peculiar distribution of the ringed seal in a number of regions of the Arctic and the Far East. This peculiarity consists in the fact that the ringed seal is less confined to shores in the northern part of the Sea of Okhotsk than in the regions of the Canadian north, /222 the Barents and Kara Seas. This is especially evident on comparison of the distribution of seals during whelping and rearing of young stock.

In the Okhotsk seal, whelping sites lie for the most part far from shores beyond the selvage of shore ice, among mobile hummocky ice alternating with leads. With respect to feeding, these sites are the best for whelping since the first accumulations of euphausids appear here in the spring. The existence of available foods is especially important for young stock in the transition to independent feeding.

The Arctic seas present a completely different picture. Both in Canada, off the shores of Baffin Island, and in the seas of the European north, the ringed seal whelps predominantly close to shores on motionless ice of bays and gulfs, making holes in the ice. Protection from wind and frost are undoubtedly important in the selection of whelping sites, but the food factor is no less important.

These findings on the feeding of the ringed seal show that small crustaceans sometimes not exceeding 10 mm in size, play a considerable role in its feeding. The adaptation of the ringed seal to the capture of such small food is of interest in this connection. McLaren (1958) considers that the ringed seal takes in small crustaceans with the water and filters them out. This seems quite plausible to us, as the structure of the dental system in the ringed seal is quite adapted for this. When the jaws close, the teeth adjoin with gaps through which the ringed seal apparently filters the water, leaving behind the entomostracans taken with it.

CONCLUSION

The ringed seal of the Sea of Okhotsk, like other subspecies of this seal, feeds on higher crustaceans and fish. Both play an important role in its feeding depending on the time of year. In the spring and summer, the ringed seal feeds mainly on crustaceans; and in the fall and partly in the winter, on fish.

In addition to similarities in feeding, different subspecies of ringed seal also show definite differences, perhaps due to specific conditions in biocoenoses of particular seas inhabited. In Arctic seas, Mysis oculata, Themisto lebulala, and gammaracanthus loricatus are the main crustaceans in the diet, Thysanoessa raschii in the Sea of Okhotsk. The arctic cod is the main food fish in Arctic seas, navaga, smelt and herring in the Sea of Okhotsk.

The peculiarities in the distribution of food objects determines the peculiar distribution of the ringed seal in a number of regions, in that the ringed seal is less confined to shores in the Sea of Okhotsk than in a number of Arctic regions.

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